Lipids and clays interactions in a productive marine water column (Antofagasta Bay, Chile)

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INTRODUCTION

A better understanding of the preservation of fresh organic matter (OM) in sedimentary environnements could provide important insights on the crude oil genesis. Although several models were proposed for the OM preservation with sediaments, few research works (Largeau et al.,1986, Damsté et al.,1990, Boussafir and Lallier-Verges 1997) were undertaken on the interaction between OM and minerals at different intra-columns zones. For this purpose, this study aims at understanding the OM adsorption onto clay mineral particles localized at different oxygenic conditions along a productive water column. This study provides new insignts about the association of clay minerals with OM of which chemical nature was clearly determined by a set of complementary techniques.

MATERIALS AND METHODS

Our in situ approach have been driven off Antofagasta, Chile (fig.1). The Bay undergoes Humboldt current on the surface. Upwelling currents sustains an important biomass. Fluorescence peak observed at 20m of depth reflects the intense proliferation of this biomass.

Natural and synthetic montmorillonites and natural kaolinite samples have been disposed along the oceanic water column at three depths corresponding to different water oxygenic conditions (oxic, transition and anoxic). After different times of exposure, the samples have been removed and characterized by different analytical techniques: pyrolysis-GC-MS (py-GC-MS), Dissolved Organic Carbon Analyser, X-Ray Diffraction (XRD) and Infrared Spectroscopy (IR).

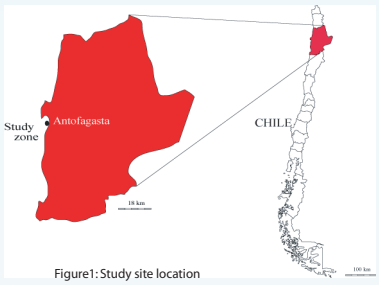


Figure1: Study site location

VARIATIONS OF DISSOLVED ORGANIC CARBON(DOC)

DOC concentrations in water volumes in contact with our clayey samples have been investigated. During first days of immersion, analyses revealed an increase of DOC concentrations near clay samples.Drouin (2007) have observed similar results in lacustrine area. This attracting effect drops following clays residence time (fig.2). In fact, clays proximal DOC concentrations tend to balance with marine column DOC concentrations after seven days.

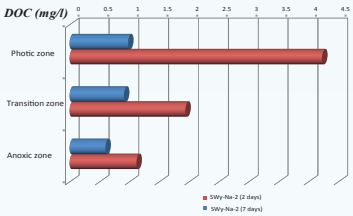
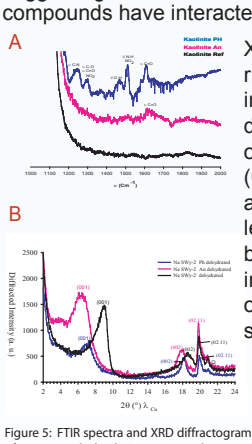


Figure 2: DOC concentrations in Natural Wyoming montmorillonites traps

MOLECULAR DIVERSITY AND CLAYS INTERLEAFS BEHAVIOR

Besides lipidic groups observed through GC/MS analyses, immersed clays have adsorbed other molecular families. IR spectra have revealed N-H, N-O vibrations (fig.5A), suggesting that amino-acids and other nitrogenous compounds have interacted.



XRD analyses on both montmorillonites samples have shown an increase of (001) plans basal distances (fig.5B), suggesting organic molecules intercalation. (02.11) plans kept the same angular value, showing that leafs internal structure have not been altered during the marine immersion. Kaolinte interactions occured entirely on its external surface.

Figure 5: FTIR spectra and XRD diffractogramms of immersed kaolinite natural wyoming montmorillonite samples compared reference samples. (Ph: Photic; An: Anoxic; Ref: Reference).

MARINE WATER INTERACTIONAL LIPIDS AND CLAYS EFFICIENCY

Water samples GC/MS analyses revealed that fatty acids are the most abundant lipidic family in solution along the water column. Besides, alkanes and aromatic compounds (benzoic alkyles, methoxy- benzenes, phenols) have been observed in lower quantities (fig.3).Clay adsorbed lipids are principally fatty acids. Aromatic compounds have also been adsorbed (fig.4).

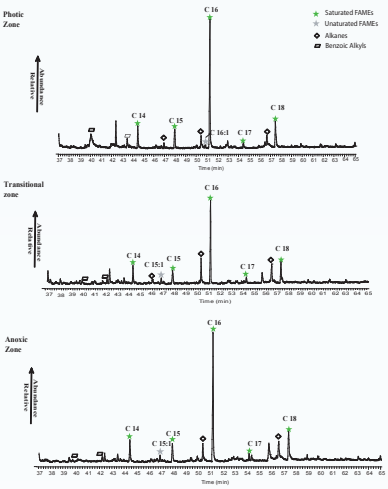


Figure 3: Total ionic currents obtained for immersed natural Wyoming montmorillonite samples.

Natural montmorillonite has been identified as the most efficient clay for global lipids adsorption. Its adsorption capacity is higher than Synthetic montmonrillonite's, which is it self superior than kaolinite's. Synthetic montmonrillonite's relative low efficiency compared to its natural homologue is likely induced by its high cristallinity state and its lack of ionic impurities.

Despite of a greater availability and a higher diversity in the photic zone, analyses revealed that lipidic groups are preferentially adsorbed in the anoxic zone, near to the water/sediments interface.

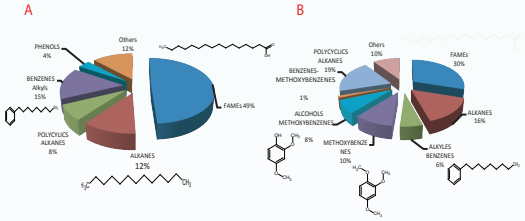


Figure 4: Lipidic diversity observed on Natural Wyoming Montmorillonite (A) and Kaolinite (B) samples immersed in the column anoxic zone.

CONCLUSIONS

-Water column organo-mineral process in Antofagasta bay involves different types of OM. Adsorbed lipidic fraction is predominated by fatty acids.

-Clay particles maximum adsorption capacity is rapidly reached (2 days of immersion). 2:1 Clay types are globally more efficient than the selected 1:1 clay type.

-The anoxic zone is the most favorable zone for lipids/clays interactions.

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